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Model-based Explanation in the Social Sciences: Modeling Kinship Terminologies and Romantic Networks

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I compare Read's model of kinship terminologies to a sociological model of a romantic and sexual network. This comparison leads to an account of how models function to construe explanations that complement Read's own account.

1.

Read argues that modeling cultural idea systems serves to make explicit the cultural rules through which "cultural idea systems" frame behaviors that are culturally meaningful. Because cultural rules are typically "invisible" to us, one of the anthropologists' tasks is to elicit these rules, make them explicit and then use them to build explanations for patterns in cultural phenomena. The main example of Read's approach to cultural idea systems is the formal modeling of kinship terminologies. I reconstruct Read's modeling strategy as comprising the following steps:

> [R1] From the way in which culture-bearers compute kin relations a data model is construed that makes explicit the cultural theory embedded in a kinship terminology.
>
> [R2] A theory model is obtained through operations performed on the data model and from a theory for kinship terminology structures.
>
> [R3] If the theory model is isomorphic to the data model, the theory is explanatory for that kinship terminology.

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In Read's account, the last step is crucial for explanation: *isomorphism* between the theory model and the data model is held to license the conclusion that the theory explains the kinship terminology of interest. Philosophers of science have been debating whether isomorphism is necessary for a model to be a representation of its target and hence to be used for learning about it (e.g., van Fraassen 1980; Giere 1988; Suppes 2002; Suarez 2003). Many have argued against this view, among other reasons because actual scientific models are rarely isomorphic to their targets. Here I need not be concerned with this aspect of the debate because in Read's model the theory model is in fact isomorphic to the data model. Nevertheless I question the presupposition that isomorphism between the theory model and the data model is *sufficient* to yield explanation. Isomorphism is a symmetric relation, but explanation is not:[1] the (theory) model explains (facts about) its target (the data model), but the target (data model) does not explain the (theory) model. So, there must be features of the theory model, absent from the data model, which make the former explanatory.[2]

2.

The question I am interested in is how the theory model contributes to the explanation of facts about the target. The comparison with a model of a social network brings out some elements that I think are downplayed in Read's account. Sociologists Bearman, Moody, and Stovel (2004; henceforth, BMS) obtain the structure of a sexual and romantic network among adolescents in an American high school from the Add Health database. The observed network is characterized by a very large component where short cycles are virtually absent. Thus, the network displays the structure of a spanning tree. BMS hypothesize different behavioral rules that could generate the observed network: random mixing, homophily in partnership selection, and a social norm against dating the old partner of the current partner of one's former partner. For each rule, or combination of them, they build a simulation and check whether it generates the observed network. The model that derives an outcome (a theory model, in Read's terminology) that matches the structure of the network (in Read's terminology, a data model) is the one that explains it. The conclusion is that the structure of the observed network is possibly the result of homophily preferences together with the social norm about partnerships. This is my reconstruction of BMS' modeling strategy:

1. Frigg (2006) makes this point about isomorphism and representation.
2. I am not referring to the degree of evidential support for the model.

[BMS1] From data about dating relationships (a model of) the network's structure is construed

[BMS2] Alternative hypotheses concerning behavioral rules are translated into computational models.

[BMS3] The computational model the outcome of which matches the data model (possibly) explains the network's structure.

As in Read's model of kinship terminologies, the BMS target can also be said to be represented in a data model. Also, in both successful replication of the structure displayed by the data model is necessary for explanation.[3] Hence the first and third steps in BMS are analogous to those I identify in Read's. The two approaches however differ in two respects. First, BMS is a simulation-based model whereas Read's is an analytical model. This difference however is not relevant to my purpose here and I will not discuss it further. More relevant are the differences in steps [R2] and [BMS2]: a theory is explicitly included in Read's but is absent in BMS and alternative simulations representing different mechanisms are explored in BMS but there is no analogous step in Read's. Should we conclude that the two modeling strategies represent different ways of construing explanations? In the following section I hope to show that the differences are less significant than they first appear.

3.

Step [BMS2] consists in hypothesizing different mechanisms to see which network structures result from them. This step is crucial to the explanatory endeavor: it serves to address *what-if-things-had-been-different questions* (Woodward 2003). That is, it is a matter of manipulating the model with the purpose of investigating what happens under different assumptions (e.g., if students are assumed to select their partners at random, a random network structure obtains that fails to display the characteristics of the data model). Manipulation here is not to be interpreted as *material* manipulation, as when in a laboratory experiment a condition is changed to learn how this change affects the outcome. The manipulations are *theoretical* instead (Mäki 2005): they consist in modifying a model's assumptions or in comparing similar models that differ for a few relevant assumptions. Such procedures enable one to draw inferences about alternative counterfactual

3. This need not always be the case. For instance, in economics a model is often regarded as explanatory when it obtains a "stylized fact", which is understood as a broad, often qualitative, generalization.

scenarios, identify what makes a difference for the explanandum and thereby postulate relationships of either *causal* or *constitutive* dependence (Woodward 2003; Craver 2007; Ylikoski 2007). Constitutive dependencies are not causal: they relate the properties of the whole system to the properties of the entities that constitute it (and their organization). In both cases, however, explanation is a matter of revealing relationships of counterfactual dependencies between the explanans and the explanandum.

In Read's case properties of the kinship terminology are explained by the generating rules for that kinship terminology. Hence, we can interpret Read's theory model as providing information about relationships of constitutive dependence. The latter bear the explanatory burden. However, Read does not talk of theoretical manipulation but identifies an explicit role for the theory—though it is not quite clear what theory means in this context. Following Geertz, Read says that "the culture theory must be a model *for* behavior by the culture-bearers, not a model *of* behavior by the observer" (p. 7). The theory "for behavior" is intended to capture the way in which culture-bearers actually compute kinship terminologies. The theory of kinship terminologies, which takes kinship terms and hence kinship terminologies to be generated through kin term products (and not through genealogical relationships) guides, but does not fully determine, the process of building models for particular kinship terminologies (pp. 13–14).

Thus, *prima facie,* model-based explanation appears to proceed differently in the two cases. Whereas in BMS it works through the manipulation and study of the theory models, in Read's the explanatory capacity of the theory model derives from its relationship to the theory. It is the theory for kinship terminology structures, implemented in the theory model, which contains the relevant information about explanatory relationships. The *activity of modeling* itself does not seem to play any independent epistemic or explanatory role. This runs counter to the current philosophical (quasi)consensus that models have an epistemic role that is independent both from theory and data (Morgan and Morrison 1999). Clearly the degree to which a model is independent from theory varies and Read's could simply be a case where the model is in fact dependent on theory.

Yet I do not think that in Read's case modeling itself plays no independent epistemic role. To see why, consider the two puzzles about kinship terminologies that Read claims are resolved by his modeling approach: the anomaly represented by the in-law suffix in the American-English terminology and the difference between classificatory and descriptive terminologies.

The explanation of the anomaly of the in-law suffix shows that the latter is not in fact an anomaly “because logically *spouse* o *aunt* (*uncle*) = *uncle* (*aunt*) . . . What *-in-law* marks . . . are the terms making up a third dimension introduced by the *spouse* term. The *spouse* product does not map *aunt* and *uncle* into this third dimension . . . and so the *-in-law* suffix does not apply” (p. 19). Because the rule was built into the theory model from the data model (step [R2] above), this explanation sounds circular. The impression of circularity however disappears if one sees the explanation as follows. Explanatory information is obtained by studying how the structure in the theory model would be different, if a different rule of term generation for spouse relations were different. Hence, manipulating the theory model gives information about the (constitutive) dependence between the specific rules of generation of kin terms of the American-English terminology the theory postulates and the terminology’s overall structure.

That studying and manipulating the theory model is a crucial step in the construction of explanations is illustrated even more clearly in the explanation of the difference between descriptive and classificatory terminologies. The comparison between the theory model of each terminology reveals how their structure is different depending on whether the concept of sibling is a generating concept or a derivative one. Similarly to the BMS case, the comparison between models that represent different processes of generation uncovers the relationship of dependence between features of the components (the specific rules of generation) and the overall outcome. Information about these relationships is then deployed for purposes of explanation.

4.

I conclude with three brief observations. First, vis-à-vis Read’s own account, the view I propose more explicitly recognizes the role the *activity of modeling* plays in the process of construing explanations. Second, and as a consequence, it highlights the *active role of the modelers,* who build the models, perform operations on them, and use them to draw explanatory inferences on the target. In other words, explanation is what modelers do by manipulating the model and studying the consequences of those manipulations. Finally, Read’s modeling approach is clearly distinctive because of its subject matter: since the culture theory is a model for behavior, the data model for behavior is structurally isomorphic to the theory model, which is itself derived from the culture theory (p. 7). Nonetheless I suggest that the process by which explanations are construed shares important similarities with other modeling approaches in the social sciences.

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